University of Bahrain
College of Information technology
Department of Computer Engineering

Test (1)

Student Name	Solution
I.D. No.	
Section	

Course Title: Digital Logic
Course number: ITCE 202/250
Semester: 1
Academic Year: 2013/2014
Duration : 1hour
Date: 29/10/2013

Read the following before you start:
1. Write your name, ID and section number
2. Answer all questions.
3. Write your answers on the attached sheets only.

Question	Mark	Mark attained
1	22	
2	16	
3	15	
4	22	
5	25	
Total	100	

Question [1]: [22 mark]

(a) Convert the following numbers showing all steps.

3 $(1111)_2 = (\quad)_{BCD}$ 15_{10} = 0001 0101 BCD

3 $(A29)_{16} = (\quad)_4$ 1010 0010 1001

2 2 0 2 2 1_4

3 $(15)_{10} = (\quad)_{excess\_3}$ 0001 0101 BCD $\xrightarrow{+3}$ 0100 1000 excess-3

3 $(-35)_{10} = (\quad)_{1\text{'s complement}}$

	64	32	16	8	4	2	1
Binary +35	0	1	0	0	0	1	1
1's Comp -35	1	0	1	1	1	0	0

(b) Add the following numbers in BCD

5 **$(97)_{10}+(25)_{10}$=**

```
      1001  0111     97
      0010  0101     25
      ----------    ---
      1011  1100    122
      0110  0110
      ----------
0001  0010  0010
```

5 **b)** Perform the following operation using 6-bit 2's complement numbers and indicate the case of an overflow.
$(-20)_{10}+(-15)_{10}$=

	32	16	8	4	2	1
+20	0	1	0	1	0	0
+15	0	0	1	1	1	1

```
 -20      101100
 -15      110001 +
 ---     -------
 -35    [1]011101
```

C = 1

V = 1

Question [2]: [16 mark]

1. Simplify the following expression using the Boolean algebra to a minimum number of literals:

8

$$\overline{A+B} + ABC + A\bar{B}$$

$\bar{A}\bar{B} + ABC + A\bar{B}$

$\bar{B}(\bar{A}+A) + ABC$

$\bar{B} + ABC$

$\bar{B} + AC$

2- Find the minimum Product of Sum for the following function, use Boolean Algebra.

8

$$(a+b)(a+b+d)(a+c)$$

$F = \bar{a}\bar{b} + \bar{a}\bar{b}\bar{d} + \bar{a}\bar{c}$

$= \bar{a}\bar{b}(1+\bar{d}) + \bar{a}\bar{c}$

$= \bar{a}\bar{b} + \bar{a}\bar{c}$

$F = (a+b)(a+c)$

cd \ ab	00	01	11	10
00	0	0		
01	0	0		
11	0			
10	0			

$\bar{F} = \bar{a}\bar{b} + \bar{a}\bar{c}$

or use $x \cdot (x+y) = x$ → Theorem 10D on Page 52

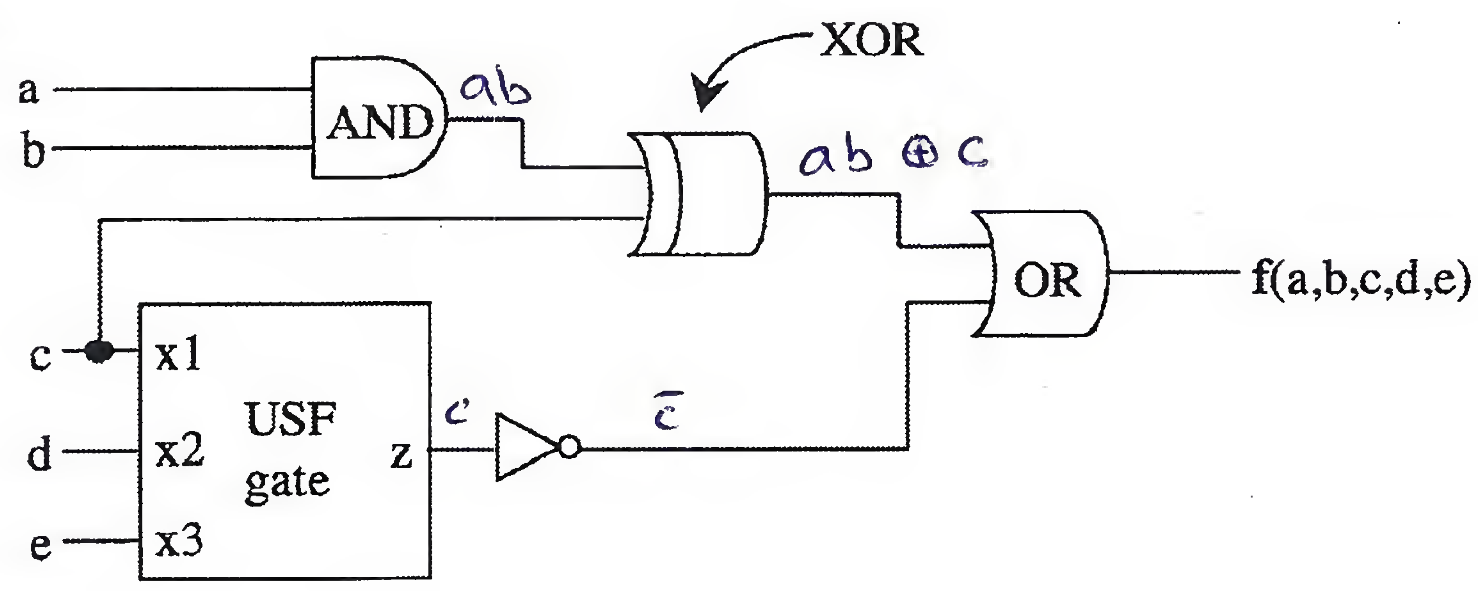
to get $(a+b)(a+b+d)(a+c)$

→ $(a+b)(a+c)$

Question [3]: [15 mark]

In the given circuit below, the gate labeled "USF gate" has the truth table shown below.

x1	x2	x3	z
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1



Write f(a,b,c,d,e) as a minimum sum of product.

3

$Z = c$

5

$f = (ab \oplus c) + \bar{c}$

$= ab\bar{c} + \overline{ab}c + \bar{c}$

$= ab\bar{c} + c(\bar{a} + \bar{b}) + \bar{c}$

$= ab\bar{c} + \bar{a}c + \bar{b}c + \bar{c}$

7

$= \bar{c}(ab + 1) + \bar{a}c + \bar{b}c$

$= \underbrace{\bar{c} + \bar{a}c} + \bar{b}c$

$= \bar{c} + \bar{a} + \bar{b}c$

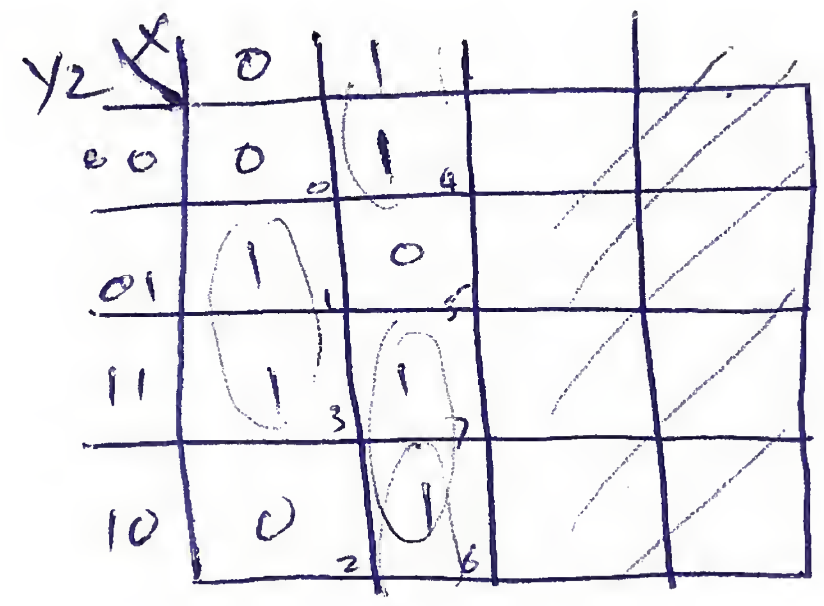
$= \bar{a} + \bar{b} + \bar{c}$

Question [4]: [22 mark]

a-- Find the maxterm expansion in algebrical expansion (in complete form) of the following expression:

8

$$F(X,Y,Z) = XY + \bar{X}Z + X\bar{Y}\bar{Z}$$



$F = \sum m(1,3,4,6,7)$.

$= \prod M(0,2,5)$

$\bar{F} = \bar{x}\bar{y}\bar{z} + \bar{x}y\bar{z} + x\bar{y}z$

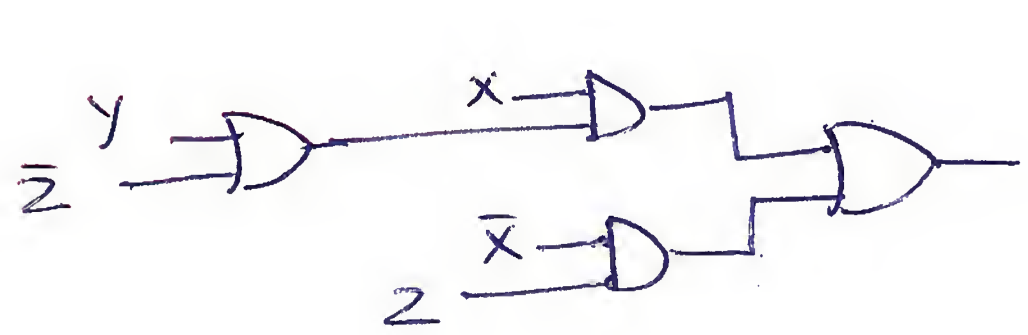
$F = (x+y+z)(x+\bar{y}+z)(\bar{x}+y+\bar{z})$

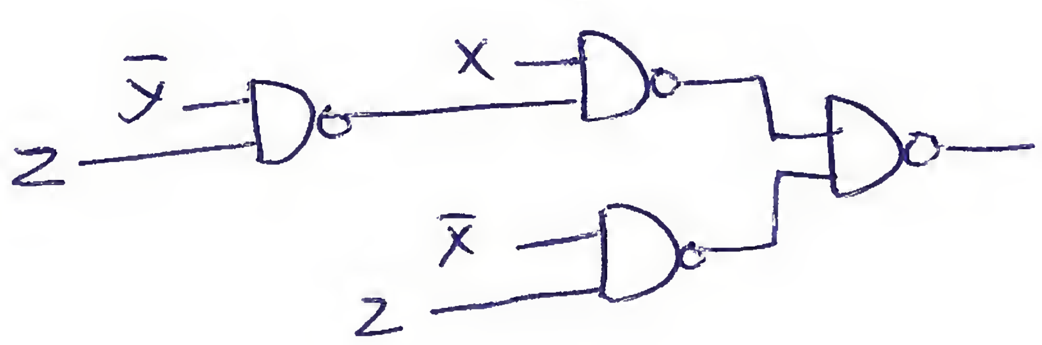
b-- Implement F using minimum 2-inputs NAND gates.

7

$F = xy + \bar{x}z + x\bar{z}$

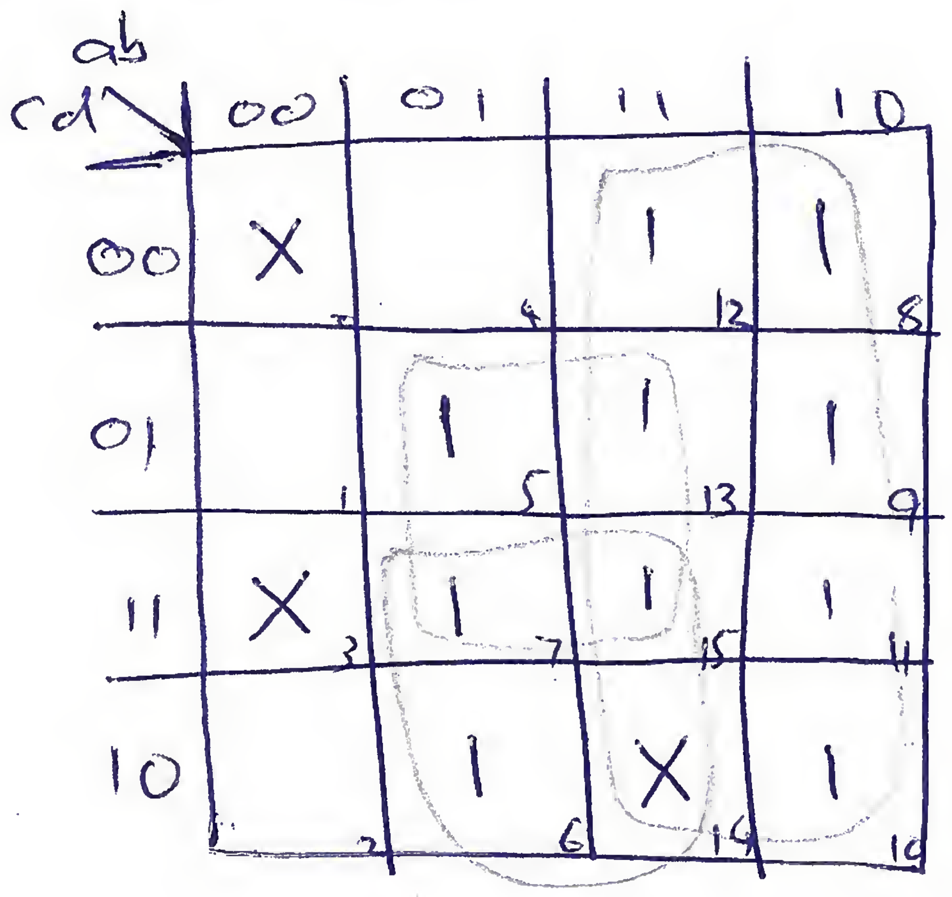
$= x(y+\bar{z}) + \bar{x}z$





C -- Write **F(a,b,c,d) = Σm(5,6,7, 8,9,10,11, 12,13, 15) + Σd (0,3, 14)** as minimum sum of product.

7



$F = a + bd + bc$

Question [5]: [25 mark]

A combinational logic circuit receives BCD numbers as input. The output (W, X, Y, Z) represents the excess-3 code of the inputs. Consider the invalid inputs as don't care cases.

5 **(a)** Construct the truth table.
5 **(b)** Find the minterm expansion of W in decimal notation.
5 **(c)** Find the maxterm expansion of X in decimal notation.
5 **(d)**) Find the minimum SOP expression of Z.
5 **(e)** Implement Y using minimum number of NOR gates only.

(a)

	ABCD	WXYZ
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100
	1010	xxxx
	1011	xxxx
	1100	xxxx
	1101	xxxx
	1110	xxxx
	1111	xxxx

b) $W = \sum m(5,6,7,8,9) + \sum d(10,11,12,13,14,15)$

c) $X = \prod M(0,5,6,7,8) \cdot \prod D(10,11,12,13,14,15)$

d)

CD \ AB	00	01	11	10
00	1	1	X	1
01	0	0	X	0
11	0	0	X	X
10	1	1	X	X

$Z = \bar{D}$

e)

CD \ AB	00	01	11	10
00	1	1	X	1
01	0	0	X	0
11	1	1	X	X
10	0	0	X	X

$\bar{Y} = \bar{C}D + C\bar{D}$

$Y = (C+\bar{D})(\bar{C}+D)$